Current Research Regarding Marine Protected Areas in the Puget Sound / Georgia Basin listed by contact person

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Biermann, Christiane. Friday Harbor Laboratories, University of Washington
Genetic population structure of Northwest Straits green sea urchins (*Strongylocentrotus droebachiensis*): The impacts of harvesting and marine protected areas (expected completion 2003).

The goal of this project is to provide scientific information that can guide marine conservation efforts in the Northwest Straits/Puget Sound region in coastal Washington. We plan to analyze the population structure of an ecologically and commercially important invertebrate species, the green sea urchin (*Strongylocentrotus droebachiensis*). We will investigate both its abundance and the genetic relatedness between different population patches. This species will serve as an easily accessible model for the diverse biota in this region. Marine Protected Areas (MPAs) are the principal management tool in the conservation of marine species and habitats. The criteria for the selection of protected areas include the capability to support healthy populations and to supply larvae to other sites, both inside and outside reserves. To select the most effective network of protected areas, we need to understand the paths of migration or dispersal of organisms. Most marine species have at least one free-swimming or drifting stage in their life history that is subject to being moved around by currents. The microscopic larvae of sea urchins are not very strong swimmers; hence their dispersal reflects physical oceanographic processes. Once they arrive in a suitable habitat, they can survive for decades. The genetic affiliation of a population therefore represents migration integrated over a long time period. It will be interesting to compare this average migration to the results of the local drift card studies, which illustrate dispersal at one point in time. We can then use the migratory (drift) path of sea urchins as a representative model for managing other rare or valuable species and the resources on which they depend. The number of green sea urchins will be surveyed inside and outside of Marine Protected Areas and fished regions (in cooperation with scientists at the Washington Department of Fish and Wildlife) by filming underwater shorelines with Friday Harbor Labs' new Remotely-Operated Vehicle. This part of the project will involve participation of K-12 students. In selected plots, sea urchins of two different size classes will be collected by SCUBA diving. Small tissue samples (tubefeet) will be taken and analyzed by genetic fingerprinting at Friday Harbor Laboratories. The identification of rapidly evolving "microsatellite" genetic markers that vary at small geographic scales is a complex procedure that has already been

completed for this species both by the Principal Investigator, Dr. Biermann, and by the collaborator, Dr. Cohen. The cooperative environments at Friday Harbor Labs and the UW's School of Fisheries are ideal for the analyses and dissemination/application of the data. We trust that the results will help us understand the dynamics of local marine populations, and to manage our natural resources wisely.

Dinnell, Paul, Skagit County Marine Resources Committee (Skagit MRC). Mount Vernon, Washington. Rocky reef bottomfish recovery in Skagit County.

Phase I of Skagit MRC's rocky reef bottomfish recovery project was conducted during 2000 and 2001. This phase considered possible management alternatives for bottomfish recovery and concluded that, for rockfish in particular, creation of several no-fish Marine Protected Areas (= Marine Reserves), were an important step for bottomfish recovery. Bottomfish Marine Reserves would essentially establish "islands of broodstock" for bottomfish species of concern, which would also serve as areas that protect natural biodiversity. These areas would help to prevent overfishing and attendant wholesale fishery closures by protecting large females that produce the bulk of the eggs and larvae for the next generations. Phase II of this project was conducted in 2001 and 2002. This phase of the project investigated eight potential sites for bottomfish reserves in Skagit County waters and rated their significance via biological and social matrices using input from published reports, a technical workshop and a public meeting of fishers and divers. Skagit MRC used these inputs to prioritize the potential of these eight sites for marine reserve status. Our results will be forwarded to the resource co-managers (WDFW and the Treaty Tribes of Washington) with the recommendation that they consider eventual establishment of two to four bottomfish in Skagit County waters.

Phase III of our bottomfish reserve project is now in the proposal stage. It includes funding for completion of baseline diver surveys of the eight potential marine reserve sites in Skagit County, presentation of our results of Phases I and II at a scientific conference, and continued coordination with the resource co-managers.

Eisenhardt, Eric. Scientific Coordinator, San Juan County Bottomfish Recovery Program

Dive surveys of bottomfish inside four San Juan County voluntary "no-take" reserves and at four non-reserve reference sites (expected completion: Dec, 2002)

Visual band transects via SCUBA are being used to monitor population density and length frequency distribution of the eight largest and most abundant species found at these eight survey sites. These eight target species include five rockfish; copper (*Sebastes caurinus*), quillback (*Sebastes maliger*), black (*Sebastes melanops*), yellowtail (*Sebastes flavidus*), and Puget Sound (*Sebastes emphaeus*), as well as lingcod (*Ophiodon elongatus*), kelp greenling (*Hexagrammos decagrammus*), and striped seaperch (*Embiotoca lateralis*). Habitat data are taken for each transect. In addition, at least two divers complete REEF roving diver surveys aimed at assessing biodiversity of fish and invertebrates. Many of the survey sites also fall into potential "biodiversity hotspots" which have been identified in the Orca Pass process, but not previously surveyed subtidally. The data collected in these efforts will be shared with People for Puget Sound and other interested groups.

Eisenhardt, Eric. Scientific Coordinator, San Juan County Bottomfish Recovery Program
Acoustic telemetry to determine home ranges of copper rockfish in Marine Protected Areas (expected completion: Feb, 2003)

Acoustic transmitter tags are being used to track the movements of copper rockfish (*Sebastes caurinus*) inside San Juan County voluntary "no-take" reserves. Tags batteries last for 60 days. Tagged fished are being located daily for the duration of battery life using a hydrophone and GPS. A mobile hydrophone array, which can locate tagged fish several times per minute, is being developed. Maps of home range size will be produced. These maps will aid in marine reserve design by answering the question: "How small is too small?" for copper rockfish.

Greene, Gary. Moss Landing Marine Laboratories
Using multibeam bathymetry to characterize rockfish habitat in San Juan County, Washington Marine Reserves, (completed 2002)

The establishment of Marine Protected Areas (MPAs) has recently become an important part of marine resource management efforts around the world and in San Juan County. Rockfish are economically important bottomfish whose populations have declined since the 1970Õs to such an extent that they are being considered threatened or endangered under the Endangered Species Act. During October of 2000, Moss Landing Marine Laboratories, Center for Habitat Studies surveyed five sites within the San Juan Archipelago (SJA) using a RESON 8101 multibeam bathymetric system. Both bathymetry and backscatter data were collected, although the system was maximized for the collection of accurate bathymetry. The main objective of this survey was to gather high-resolution bathymetric data to be used in mapping adult and juvenile rockfish habitat as part of an effort to identify potential marine reserves within the SJA. Sites were chosen based upon previous knowledge of the areasÕ physical oceanographic and biological conditions. Surveys were undertaken within San Juan Channel, southern Haro Strait, and southern Rosario Strait. Areas of rugged rocky seafloor were identified using both qualitative and quantitative methods, and were interpreted to be potential adult and juvenile rockfish habitat. Potential habitat bridges radiating outwards from protected areas were outlined based upon visual interpretation of multibeam imagery. Three voluntary no-take zones (VNTZs); Pile Point, Charles Island, and Bell Island established by the San Juan County Marine Resource Committee (MRC) in 1997 were evaluated based upon the presence of potential adult and juvenile rockfish habitat and the existence of possible habitat bridges that radiate outward from the protected areas. Results show that Pile Point, Charles Island, and Bell Island VNTZs appear to contain viable refugia for adult and juvenile rockfish and prospective habitat bridges that radiate outwards from the VNTZs. Alternative reserve locations were also identified that may provide protection for species other than bottomfish

Gunderson, D. and B. Miller, Friday Harbor Laboratories, University of Washington

The University of Washington (Friday Harbor Laboratories/School of Aquatic and Fishery Sciences) has taught 5 undergraduate apprentice courses since 1999, which have resulted in considerable information of use in implementing MPA networks near San Juan Island. Student projects have maintained time series of SCUBA transects, and

examined distribution of rockfish larvae, use of nearshore habitats by fish and shellfish, age/growth relationships, food habits, and adult home range. The course is currently underway (Fall quarter, 2002) and will be offered again during Spring quarter, 2003.

Several graduate students working under Dr. Bruce Miller are pursuing thesis topics that relate to MPA design. These include juvenile lingcod ecology, larval distribution of rockfish, and copper rockfish fecundity

Klinger, Terrie. University of Washington
Larval rockfish dispersal trajectories in the Georgia Basin/Puget Sound Region of Washington state (expected completion 2004)

We propose to use trace element analysis of otoliths from adult and larval rockfish in the Georgia Basin/Puget Sound region to determine the sources from which larvae originate and the oceanographic regions they occupy during the larval dispersal phase. The elemental composition of fish otoliths has been used successfully to identify stock structure, recruitment patterns, and dispersal pathways for a number of fish species from tropical and temperate regions. The technique has great potential for use in the Georgia Basin/Puget Sound region because of the strong riverine and oceanic signals provided by inputs from the Fraser River and Strait of Juan de Fuca, respectively. We propose to use two species of rockfish as model systems. Copper rockfish (*Sebaster caurinus*) and quillback rockfish (*S. maliger*) are species of local importance. Both have shown sharp declines in abundance over the last few decades, and both are now important regional conservation targets. The research we propose is highly relevant to problems of bottomfish recovery, marine conservation, and marine protected area design. The results of our research will indicate whether populations of these rockfish species constitute open populations characterized by substantial long-distance larval dispersal, or whether these are closed populations in which larval dispersal is spatially limited. Our results will help guide the design and implementation of marine protected area networks in the Georgia Basin/Puget Sound region and throughout Washington State.

Osborne, Richard W., The Whale Museum
Evaluating near-shore buffer zones in the San Juan Islands National Wildlife Refuge System relative to their function as marine protected areas (expected completion 2003)

The San Juan Islands National Wildlife Refuge System and Wilderness Areas consist of 83 small islands and rocky reefs in San Juan, Whatcom and Skagit Counties in northwestern Washington State. These refuges were federally designated in 1976 as "no take" terrestrial reserves and are intended to confer protection to marine birds and mammals by protecting important nesting, loitering and haul-out sites. In addition to the terrestrial components of the reserves, federal guidelines recommend that each reserve be surrounded by a 200 yard buffer zone in which boating is discouraged (Murray. 1998). We propose that these buffer zones constitute defacto MPAs, and that compliance with the federal recommendation will increase substantially the amount of protection offered to living marine resources in San Juan Archipelago. The objective of the proposed study is to quantify the potential and actual contributions of these near-shore buffer zones to marine protection within the San Juan Archipelago. We believe that the San Juan Islands National Wildlife Refuge System provides a politically feasible means of enhancing protection for marine resources through the implementation of existing management

strategies, without requiring that new protected areas be set aside or removed from public use. This project builds upon a 5-year effort by The Whale Museum's Soundwatch Boater Education Program to opportunistically implement the refuge system buffers through education (Osborne et al., 2001), and a pilot study initiated in 2001 by The Whale Museum and the Washington Maritime National Wildlife Refuge System to promote voluntary compliance in buffer zones around two of the reserves. Here we propose to 1) formally map and evaluate the physical and biological attributes within buffer zones throughout the refuge system based on existing data, 2) undertake systematic surveys of vessel activity around the reserves, and 3) intensively patrol and educate the boating public at five of the reserves. The products of this work will be provided to federal, state, and local agencies and other interested parties, will be submitted for publication in peer-reviewed journals, and will partially fulfill the requirement for a Master of Marine Affairs at the University of Washington.

Palsson, Wayne, Washington Department of Fish and Wildlife (WDFW)

WDFW is the principal agency in Puget Sound to designate no-take marine reserves for non-tribal fisheries. There are presently 18 marine reserves that range from intertidal beach reserves to rocky habitat reserves. Protection ranges from partial no-take to complete no-take. The agency is involved in a number of research efforts focused on how fish populations respond to protection from harvesting, examining the trophic roles and changes in marine reserves, and designing and selecting marine reserve sites. On-going research includes:

1. Reserve Monitoring -Scientists with the Marine Fish Science Unit have demonstrated long- and short-term responses of fishes to marine reserve protection. They continue their efforts at WDFW's reserves by monitoring changes to species composition, fish density, size, and reproductive output at a core of reserves and fished areas in Puget Sound and the San Juan Islands. In addition, other reserves are periodically examined for changes in species composition and size.

2. Successional and Trophic Changes -A new project is beginning to examine the successional changes in fish communities in Puget Sound's marine reserves. Attention will be paid to smaller prey species and to unclassified marine fishes that are not typically observed during other monitoring. Trophic relationships will also be examined by comparing fished areas, new reserves, and old reserves to test the effects of accumulating high densities of large predators in reserves.

3. Reserve Design -WDFW is examining criteria for selecting new reserves and for creating a network of rocky habitat and ecosystem reserves. These activities include examining fish-habitat relationships, movement and dispersal patterns of adults and larvae, and oceanographic features. One area of research is determining whether strontium chloride can be used as a trans-generational mark for rockfish with the hopes of determining the origin of young rockfish.

Strathmann, Richard. Friday Harbor Marine Laboratories, University of Washington
Do marine reserves safeguard native species from impacts of non-native invasive species? (completed 2002)

A soft-shelled non-indigenous clam, Nuttallia obscurata, has invaded coastal soft-sediment habitats of the northeastern Pacific. In a survey of 35 sites within the San Juan

Islands, Washington, USA, *Nuttallia* was found almost exclusively in sandy substrates, higher in the intertidal than most native clams (>1 m above mean lower low water). The distinctive distribution of *Nuttallia* suggested that tidal height and sediment composition may be important physical factors that control its refuge availability, regulating its exposure to predation and ultimately the success of its invasion. I tethered Nuttallia for 24 h in the high intertidal where it is typically found and in the low intertidal at an elevation where it was never found. Clams restrained to the surface suffered high mortality from crab predation at both tidal heights, whereas control clams with unrestricted burrowing movement exhibited high mortality rates only in the low intertidal. In a second experiment, I transplanted sediment within and between the two intertidal heights to measure effects of tidal height and sediment type on survival and burial depth of *Nuttallia*. At both tidal heights all clams placed on mud-cobble substrate, naturally common in the low intertidal, suffered high mortality rates (>60% in 24 h). *Nuttallia* on loosely packed sand substrate, naturally found in the upper intertidal, survived much better, however, because they buried deeper than in the tightly packed mud. Caged control clams at both tidal heights suffered no mortality. Apparently native predators are mitigating community level impacts of an invader by excluding Nuttallia completely from some beaches with improper sediment characteristics or relegating it in others to a zone not often inhabited by native species, thereby reducing potential competitive interactions. These findings show that a physical habitat characteristic can mediate biotic resistance to an invader and thus control invasion success and community-level impacts. Generally, such physical-biological interactions may explain some of the reported site-to-site variability in invasion success, as well as the patchy distribution of many soft-sediment infaunal species